

## **CHAPTER 8**

### **CONSTRUCTED CHANNELS**

## **8.1 Introduction**

Constructed channels include permanent constructed channels and temporary diversions. Temporary diversions shall be designed in accordance with requirements of Chapter 11. This chapter describes permanent constructed channels, including paved channels.

## **8.2 Permanent Constructed Channels**

Constructed channels include roadside channels and stormwater drainage channels with regular geometric cross-sections and lining of natural or synthetic materials to protect against erosion.

Safety of the general public shall be an important consideration in the selection of cross-sectional geometry of constructed channels.

The design of channels shall consider the frequency and type of maintenance expected and make allowance for access of maintenance equipment.

### **8.2.1 Design Criteria**

Constructed channels shall be designed with stable side slopes. Vegetated channels shall have sideslopes of 3:1 or flatter.

Constructed channels in residential areas that receive runoff from a storm sewer or culvert shall be constructed with a paved trickle channel. The trickle channel shall be designed to carry 50% of the 1-year storm. A detail is shown in Figure 8-1.

Channel freeboard shall be one foot or two velocity heads ( $\text{velocity head} = V^2/2g$ ), whichever is larger.

Channels with bottom widths greater than 10 feet shall have a minimum bottom cross slope of 12 to 1.

Maximum design depth shall be based on the 100-year storm.

### **8.2.2 Channel Lining**

Use channel linings to stabilize the slopes and bottoms of constructed channels. Evaluate vegetative lining first. If a vegetated channel is not stable, other alternatives shall be considered in the order shown below:

- vegetative with a turf reinforced mat (TRM)
- other hard armor such as gabion mattress, dry stone masonry, tri-loc, etc.
- concrete

Where there is a base flow and the channel does not have a natural rock bottom, the bottom of the channel shall have a non-vegetative lining.

### **8.2.3 Manning's Equation**

Use the Manning Equation to design open channels.

$$Q = (1.49/n)AR^{2/3} S^{1/2}$$

Where:

Q = discharge, cfs  
 n = Manning's roughness coefficient  
 A = cross-sectional area of flow, ft<sup>2</sup>  
 R = hydraulic radius = A/P, ft  
 P = wetted perimeter, ft  
 S = channel slope, ft/ft

Select Manning's n from Tables 8-1 and 8-2.

#### **8.2.4 Tractive Force**

After sizing the channel and determining the normal flow depth corresponding to the design storm, check the suitability of the channel lining using the tractive force method. The maximum tractive force at normal flow depth,  $\tau_d$ , is calculated as:

$$\tau_d \text{ (lbs/ft}^2\text{)} = 62.4yS$$

Where:

y = normal depth (ft)  
 S = channel slope.

The critical tractive force,  $\tau_c$ , for many linings can be found in Table 8-3. If  $\tau_d < \tau_c$ , the lining is acceptable. Options for redesign include selecting a more resistant lining or decreasing the flow velocity by decreasing the channel bed slope or side slopes or increasing the width.

For linings not listed in Table 8-3, use the manufacturer's literature to determine the critical tractive force and submit documentation with the design. For mats, nets, or TRMs use the critical tractive force in the unvegetated condition.

#### **8.2.5 Construction Specifications**

All ditches or other depressions to be crossed shall be filled before construction begins or as part of construction, and the earth fill used to fill the depressions shall be compacted using the treads of the construction equipment. All old terraces, fence rows, or other obstructions that will interfere with the successful operation of the channel shall be removed.

The earth materials used to construct the earth fill portions of the channel shall be obtained from the excavated portion of the channel or other approved source.

The earth fill materials used to construct the channel shall be compacted by running the construction equipment over the fill in such a manner that the entire surface of the fill will be traversed by at least one tread track of the equipment.

The completed channel shall conform to the cross section and grade shown on the design plans.

**TABLE 8- 1**  
**MANNING’S n FOR CONSTRUCTED CHANNELS**

<b>Lining Type</b>	<b>Manning’s n</b>
Concrete	0.013
Grouted Stone	0.030
Stone Masonry	0.032
Bare Soil	0.020
Rock Cut	0.035
Jute Net	0.022
Straw with Net	0.033
Curled Wood Mat	0.035
6-inch D <sub>50</sub> Riprap	0.050
12-inch D <sub>50</sub> Riprap	0.060
Grass	0.045

**TABLE 8- 2**  
**MANNING’S n FOR STREAMS AND FLOODPLAINS**

	<b>Manning’s n</b>
<b>Streams</b>	0.045
<b>Floodplains</b>	
Pasture, no brush	0.035
Brush	0.10
Trees	0.120

**TABLE 8- 3**  
**SUMMARY OF CRITICAL TRACTIVE FORCES FOR VARIOUS PROTECTION**  
**MEASURES**

<b>Protective Cover</b>	<b><math>\tau_c</math>(lbs/ft<sup>2</sup>)</b>
Grass or Grass-legume Mixture Good Stand	1.0
Jute Net	0.45
Straw with Net	1.45
Curled Wood Mat	1.55
Turf Reinforcement Matting (TRM)	6-10
Riprap D <sub>50</sub> = 6 inches	2.50
D <sub>50</sub> = 12 inches	5.00

### **8.2.6 Maintenance**

Channels shall be inspected regularly to check for points of scour or bank failure; rubbish or channel obstruction; rodent holes; breaching; and excessive wear from pedestrian or construction traffic.

Channels shall be repaired at the time damage is detected. Sediment deposits shall be removed from adjoining vegetative filter strips when they are visible.

Channels shall be reseeded and fertilized as needed to establish vegetative cover.

### **8.3 Paved Channels**

A paved channel shall be used when the flow velocity at design capacity (using vegetative lining) exceeds 12 fps.

#### **8.3.1 *Design Criteria***

Paved channels shall be designed to carry the peak flow from the 100-year storm.

The outlets of paved channels shall be protected from erosion using gabion mattresses. The length of the gabion mattress shall be one foot for each one fps of velocity. The width of the gabion mattress shall extend one foot in elevation beyond the top elevation of the paved channel.

Cutoff walls shall be constructed at the beginning and end of each channel except where the channel connects with a catch basin or inlet.

#### **8.3.2 *Material Specifications***

Paved channels shall be constructed of concrete or interlocking concrete blocks.

#### **8.3.3 *Construction Specifications***

The subgrade shall be constructed to the required elevations. All soft sections and unsuitable material shall be removed and replaced with suitable material. The subgrade shall be thoroughly compacted and shaped to a smooth, uniform surface. The subgrade shall be moist when pouring concrete.

#### **8.3.4 *Maintenance***

Before permanent stabilization of the slope, the structure shall be inspected after each rainfall. Any damages to the channel or slope shall be repaired immediately.

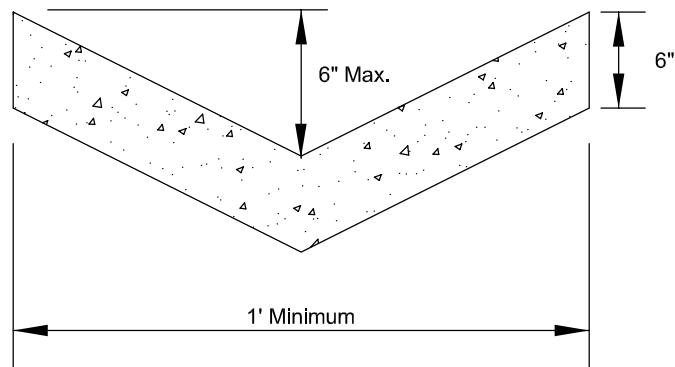
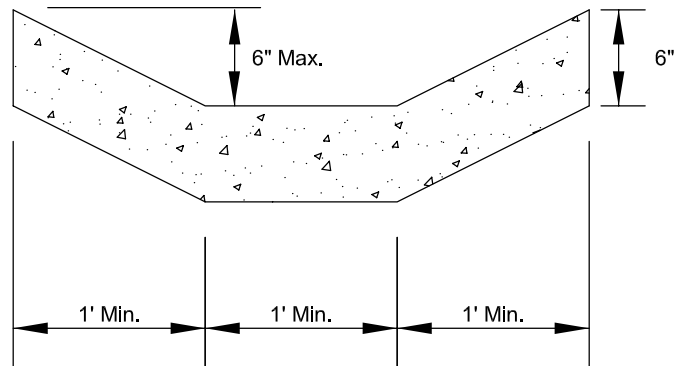


# STORMWATER MANUAL

## FIGURE 8-1

### TRICKLE CHANNELS

(EFFECTIVE DATE 1/01/09)



### TRICKLE CHANNELS

Note: The trickle channel shall be designed to carry 50% of the 1-year storm.